

EXPLORATION FOR AND IMPORTATION OF NATURAL ENEMIES
OF THE GYPSY MOTH, *LYMANTRIA DISPAR* (L.)
(LEPIDOPTERA: LYMANTRIIDAE), IN NORTH AMERICA:
AN UPDATE

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Abstract.—A compendium report of explorations, importations, and releases of exotic natural enemies of the gypsy moth in the United States, published in 1981, is updated. Changes in scientific nomenclature of the natural enemies, and information on explorations and importations, that have occurred from 1978–1985, and literature published during that period, are reported. A complete record of importations from 1963–1985 is provided. One pupal parasite, *Coccygomimus disparis* (Viereck) (Ichneumonidae), is established in the United States as a result of these importations. A second parasite, *Meteorus pulchricornus* (Wesmael) (Braconidae), has been recovered and may be considered provisionally established. Data on importations of gypsy moth natural enemies into Canada, which began in 1976, are also summarized.

There exist excellent accounts and records of the importation and release of foreign natural enemies of the gypsy moth, *Lymantria dispar* (L.) (Lep.: Lymantriidae), in the United States since foreign explorations began in 1905 through 1960. The most comprehensive of these records are by Howard and Fiske (1911), Burgess and Crossman (1929), Dowden (1962), and the more recent summary by Clausen (1978).

In 1981, a compendium report (Doane and McManus, 1981) was published by the U.S. Department of Agriculture presenting the results of extensive cooperative research on the gypsy moth and on various measures for its control that had been conducted primarily under specially authorized funds. (The Expanded Research, Development and Application Program was funded through the U.S. Department of Agriculture (USDA) from 1975–1978; an earlier accelerated gypsy moth program was funded by the USDA from 1971–1974 (McManus and McIntyre, 1981).) Included in the 1981 book was a section on parasites (Chapter 6.1), various

portions of which were written by a number of cooperating scientists, and a major portion of which represented a description of the gypsy moth natural enemy exploration, importation and release activities that had been conducted from 1961 through 1977.

Since 1977, which was the cut-off date for manuscripts submitted for the compendium report finally published in 1981, there have been 1) a number of important taxonomic papers published which permit the up-dating of the scientific nomenclature used for the natural enemies in the 1981 publication, and 2) additional explorations, importations, releases, and recoveries of exotic natural enemies of the gypsy moth. The purposes of this paper are 1) to up-date the record of foreign species of gypsy moth natural enemies shipped to the United States, presented in Table 6.1-1 of the 1981 publication, 2) to provide corrected and new scientific names for the natural enemies as required, 3) to extend the record of importations from 1978–1985, and 4) to correct several errors in the original table. A brief account will also be given of the foreign exploration activities that have been conducted from 1978 through 1985, and of the publications relating to gypsy moth foreign explorations that have appeared since 1977 and thus did not appear in the 1981 publication.

Release information as such is not a subject for discussion here. We record shipments only to the point of "Shipped from quarantine"; field releases may not have ultimately resulted. A summary record of the releases of gypsy moth natural enemies in the United States, 1963–1977, was published by Doane and McManus (1981). In addition, Dr. Richard J. Dysart, ARS, Beneficial Insects Research Laboratory, Newark, Delaware, is completing a more detailed computerized record of the releases of gypsy moth parasites and predators from 1962 through 1985. These records will be published, and will complete the accounting of the most recent period of foreign exploration, importation and release of natural enemies of the gypsy moth in the United States.

TAXONOMY AND NOMENCLATURE

Authors preparing papers for the parasite section of Doane and McManus (1981) benefited from having at hand the recent taxonomic treatise on the tachinid (Diptera) parasites of the gypsy moth by Sabrosky and Reardon (1976). The nomenclature for that group of parasites is thus fairly up-to-date. Since then, similar treatises have appeared concerning the braconid and ichneumonid (Hymenoptera) parasites of the gypsy moth by Marsh (1979) and Gupta (1983), respectively. Other taxonomic publications that pertain to the species listed and nomenclature used in Doane and McManus (1981) are the Catalog of Hymenoptera of North America by Krombein et al. (1979), the revision of Oriental Pori-zontini (Ichneumonidae) by Gupta and Maheshwary (1977), and the revision of the braconid subfamily Microgastrinae by Mason (1981).

These sources, and some unpublished manuscripts and identifications received after 1977, were utilized in the preparation of Table 1, presented here, which is a revision and extension of Table 6.1-1 of Coulson (1981). P. M. Marsh, USDA, ARS, Systematic Entomology Laboratory, Beltsville, Maryland, has very kindly provided the correct generic placement for those species formerly in the genus *Apanteles* (Braconidae) that were not listed by Mason (1981).

FOREIGN EXPLORATION AND IMPORTATION

A number of papers were published after 1977 presenting more details of the explorations discussed in Doane and McManus (1981): in Morocco (Hérard, 1979; Hérard and Fraval, 1980); Poland (Drea and Fuester, 1979); Iran (Hérard et al., 1979); Austria and Germany (Fuester et al., 1983); Japan (Schaefer et al., 1979; Schaefer and Shima, 1981; and Schaefer and Ikebe, 1982); and India (Dharmadhikari et al., 1985). A manuscript concerning explorations in France is in preparation by RWF and others.

Other than one additional exploration trip, to Romania in 1978 specifically for collection of pupal parasites (see Hedlund and Mihalache, 1980), the gypsy moth activities of the Agricultural Research Service (ARS) European Parasite Laboratory (EPL) in Europe were confined to "mail order" type collections in 1978–1985. (See Drea, 1978, for a summary of EPL's earlier work.) Such collections were made in France, Austria, and by cooperative arrangements, in Italy (Sardinia). The natural enemy species that were shipped to the United States as a result of those collections are reported in Table 1.

The ARS Asian Parasite Laboratory in Japan continued its field studies in Japan and Korea during 1978 to 1981, and the natural enemies shipped to the U.S. are shown in Table 1. In February 1982, the Laboratory was moved to Seoul, South Korea, and during that year surveys for natural enemies of the gypsy moth were carried out but no shipments were made to the U.S. Shipments of natural enemies from South Korea were made in 1983–1985 and are reported in Table 1.

In 1984, Richard S. Soper (ARS, Plant Protection Research, Ithaca, New York) collected an entomogenous fungus in Japan, where it was causing considerable mortality of gypsy moth larvae on the west coast of Honshu, and brought isolates back for study and experimental release of the fungus in the United States (see Table 1).

In 1981, as a direct result of the publication (Marsh, 1979) of descriptions of new species of braconid parasites of the Indian gypsy moth, *Lymantria obfusca* Walker, discovered during earlier explorations in India by the Commonwealth Institute of Biological Control (CIBC) as reported by R. C. Reardon and Coulson (in Doane and McManus, 1981), RWF entered into another contract with the Indian Station of the CIBC for collection of specific parasite species. The natural enemies collected in India and shipped to the U.S. by Dr. G. Ramaseshiah of CIBC in 1981, and again under contract in 1982, are shown in Table 1. Some of these parasites, especially the braconid *Glyptapanteles flavicoxis* and the ichneumonid *Hyposoter lymantriae*, appear quite promising, particularly for use in parasite augmentation programs against the gypsy moth. Several of the species were placed in culture from which releases continued through 1985.

Also in 1981, a team of forest entomologists from USDA's Forest Service (USFS) and the Pennsylvania Bureau of Forestry traveled to the Soviet Union, and they were able to collect gypsy moth natural enemies for shipment to the U.S. (Ticehurst, 1982; Coulson, 1982). The species received from these collections in the Ukraine are listed in Table 1.

Beginning in 1979, a series of visits to the People's Republic of China by U.S. biological control specialists was carried out under a U.S./PRC Agreement on Cooperation in Science and Technology (see Coulson et al., 1982; McFadden et

Table 1. Foreign species of gypsy moth natural enemies shipped to the United States, 1963-1985¹

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ³				Shipped from Quarantine ⁴	
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85
Hymenoptera:						
Braconidae:						
" <i>Apanteles</i> " spp. indet. (See also <i>Glyptapanteles flavicoxis</i> and <i>G. indiensis</i>)	S ² , ⁵ Y ² , ⁶ In ² ?	In*	In?*	In(81-82)	+	-
<i>Cotesia melanoscela</i> (Ratzeburg) (= <i>Apanteles melanoscelus</i> (Ratz.))	Y, ⁶ In ⁷	A, F, G, M, Y	A, F, In, Ir, J, P	Sa(80), J, U(81), K(83-85) ²⁶	+	+
(= <i>A. solitarius</i> (Ratzeburg))						
(= <i>A. ?ruidus</i> Wilkinson)						
(= " <i>A. spp.</i> " indet., in part)						
<i>C. schaeferi</i> (Marsh) (= <i>Apanteles schaeferi</i> Marsh (= " <i>A. n.sp.</i> ")			J	J(78) K(83-85)	+	+
<i>Dolichogenidea lacteicolor</i> (Viereck) (= <i>Apanteles lacteicolor</i> Viereck)			F†, In, Ir	In(81-82)	+	-
<i>Glyptapanteles flavicoxis</i> (Marsh) (= <i>Apanteles flavicoxis</i> Marsh (= " <i>A. spp.</i> " indet. from India (Kulu), in part)	In ² ?	In*	In*	In(81-82)	?	+
(= " <i>A. sp. nr. conspersae</i> ")						
<i>G. indiensis</i> (Marsh) (= <i>Apanteles indiensis</i> Marsh (= " <i>A. spp.</i> " indet. from India (Srinagar), in part)	In ² ?	In*	In*	In(81-82)	?	+
(= <i>A. liparidis</i> from India, at least in part)						
<i>G. liparidis</i> (Bouché) (= <i>Apanteles liparidis</i> (Bouché)) (= " <i>A. spp.</i> " from Yugoslavia, in part) (See also <i>G. indiensis</i>)	S ² , ⁵ Y, In ² ?	A, F, G, J, Y	A, F, In ² , Ir, J, M, P, Y	F(81,85), In(81), Ch*, K*(83,85)	+	+

Table 1. Continued.

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ¹				Shipped from Quarantine ⁴	
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85
<i>G. porhethriae</i> (Muesebeck) (= <i>Apanteles porhethriae</i> Mues.)	S	A, F, G, M	A, C, F, M, P	Sa(80), U(81)	+	-
<i>Meteorus pulchricornis</i> (Wesmael) (= <i>M. japonicus</i> Ashmead) (= <i>M.</i> spp. indet.)		A, F, M, Y	A, Ir, J*, M, P	A, F, U*(81), K(84)	+	+
† <i>M. versicolor</i> (Wesmael)			F		+	
<i>Protapanteles lymantriae</i> (Marsh) (= <i>Apanteles lymantriae</i> Marsh)			J(79)		-	
<i>Rogas indiscretus</i> Reardon (= <i>Rogas</i> sp.)	In		In		+	
<i>R. lymantriae</i> Watanabe			J	J(78)	+	-
Ichneumonidae:						
<i>Casinaria arjuna</i> Maheshwary & Gupta				K(83-84)		+
<i>Casinaria elegantula</i> Maheshwary & Gupta				In(82)		-
<i>C. nigripes</i> (Gravenhorst) (= <i>C.</i> spp. indet.)		F	A*	F(84)	+	-
<i>C. tenuiventris</i> (Gravenhorst)						-
<i>Coccygomimus disparis</i> (Viereck) (= <i>C.</i> sp. indet. from India, in part) (= <i>Pimpla</i> sp.)	In*	A, F, G In	J	A, F(81) K(84)	+	+
<i>C. instigator</i> (F.)		M, Y	Ir, P	R(78)	+	+
<i>C. moraguesi</i> (Schmiedeknecht) (= <i>C. turionellae moraguesi</i> (Schm.)) (= <i>Pimpla</i> sp.)		M			+	

Table 1. Continued.

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ¹					Shipped from Quarantine ⁴	
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85	
<i>C. turionellae</i> (L.) (= <i>C. t. turionellae</i> (L.)) (= <i>C. sp. indet. from India, in part</i>) (= <i>Pimpla sp.</i>)	In*	In		R(78)	+	+	
<i>C. spp. indet.</i>		C	M*		+		
<i>Ephialtes compunctor compunctor</i> (L.)				R(78)		+	
† <i>Gregopimpla himalayensis</i> (Cameron) ⁸				J(78)		-	
<i>Hyposoter lymantriae</i> Cushman		A, F, G	A, F, P	In(82)		+	
<i>H. tricoloripes</i> (Viereck)		M	M*	F(80)		+	
<i>Ichneumonid spp. indet.</i> ⁹	Y		Ir		+		
<i>Lynantrichneumon disparis</i> (Poda)			P				
† <i>Meloboris</i> (sens. lat.) sp.		A*, F*, G?*, Y?*	P	K(84-85)		+	
<i>Phobocampe lymantriae</i> Gupta (= <i>P. spp. indet., in part</i>)	Y?						
<i>P. umicincta</i> (Gravenhorst) (= <i>P. disparis</i> (Viereck)) (= <i>P. spp. indet., in part</i>)	Y?	A, F, G	A, F, Ir*, Y	J(78), F*(80,85), J*, U*(81)	+	+	
<i>Theronia atalantiae atalantiae</i> (Poda)							
† <i>Tranosema rostrale</i> (Brischke) (= " <i>T. arenicola</i> ")			P		+	+	
<i>Vulgichneumon sp.</i> ¹⁰ (= <i>Melanichneumon sp.</i>)		M	M*				
Eulophidae:							
† <i>Trichoplectrus laeviscuta</i> (Thompson) (= <i>Euplectromorpha "laeviscuta</i> (Thompson)")		F				-	

Table 1. Continued.

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ¹			Shipped from Quarantine ⁴		
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85
Encyrtidae:						
<i>Ooencyrtus kivanae</i> (Howard)		F, M*			+	
Eupelmidae:						
<i>Anastatus disparis</i> Ruschka ¹¹ (= <i>A. japonicus</i> Ashmead) (= <i>A. bifasciatus</i> (Fons.)) (= <i>A. sp.</i> "blue" ex France) <i>A. ?kashmirensis</i> Mathur <i>A. spp.</i> indet. ¹³		F	A, F	J*(78-79), Ch*(81)	+	+ ¹²
Torymidae:						
<i>Monodontomerus aereus</i> Walker	In		In I*		+	+
Chalcididae:						
<i>Brachymeria intermedia</i> (Nees) <i>B. lasus</i> (Walker) ¹⁴ (= <i>B. "euplocae"</i> of authors) <i>B. spp.</i> indet. ¹⁵	S, In	C, F, M, Y	In*, M* In, J	R(78) K(78,84)†	+	+
Scelionidae:						
<i>Gryon</i> sp. indet. ¹⁶ <i>Hadronotus</i> sp. indet. <i>Telenomus</i> spp. indet.			M F M ¹⁶		- - -	
Family indet. "Hymenoptera sp. indet." ⁹	Y				+	

Table 1. Continued.

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ¹			Shipped from Quarantine ³		
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85
Diptera:						
Sarcophagidae:						
<i>Agria affinis</i> (Fallén)		F, Y		J(79)	+	-
<i>Robineauella pseudoscoparia</i> (Kramer) ¹⁷ (= " <i>Sarcophaga</i> sp.")						
Tachinidae:						
<i>Blepharipa pratensis</i> (Meigen) (= <i>B. scutellata</i> (R.-D.))		A, C, F, G, Y	A*, F*, P*		+	
<i>B. schineri</i> (Mesnil)			J†	J(79) Ch(83), K(85)	-	+
† <i>B. "sericariae</i> (Rondani)"			J		-	
<i>B. sp. indet.</i> ¹⁸			J	J(78-79)	-	-
<i>Blondelia nigripes</i> (Fallén)			P	U(81)	+	-
<i>Carcelia separata</i> (Rondani) (= <i>C. "excisa"</i> of authors)		A, F	A, Ir, M, P	F(81)	+	-
<i>C. sp. indet.</i> ¹⁹		Y			+	
<i>Ceranthia samarensis</i> (Villeneuve) (= <i>Siphona samarensis</i> (Vill.))		A			-	
<i>Compsilura concinnata</i> (Meigen)		A, F, Y	Ir*, J*, M*, P*	U(81)	+	+
<i>Euphorocera</i> sp. indet.		F			+	
<i>Eusisyropa</i> sp. indet.		F			+	
<i>Exorista japonica</i> (Townsend) (= " <i>Parasetigena</i> sp." in part)			J	J(78-79)	+	-
<i>E. larvarum</i> (L.)		Y	Ir	R(78)	+	+
<i>E. rossica</i> Mesnil		In			+	
<i>E. segregata</i> (Rondani) (= <i>Tricholyga segregata</i> (Rond.))		S			+	

Table 1. Continued.

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ¹				Shipped from Quarantine ⁴	
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85
† <i>E. sorbillans</i> (Wiedemann)			K		-	
<i>Palexorista disparis</i> Sabrosky ²⁰ (= " <i>Drino discreta</i> " of authors) (= <i>Palexorista</i> sp.)	In	In			+	
<i>P. inconspicua</i> (Meigen) (= " <i>Drino inconspicuoidea</i> " of authors)	In	F			+	
<i>P. spp.</i> indet. (2 spp.?)		F, Y	M*		+	
<i>Parasetigena silvestris</i> (Robineau-Desvoidy) (= " <i>P. agilis</i> " of authors)		A, F, G, Y	A*, F*, J*, P*	J(79), Ch(83) K(85)	+	+
<i>P. spp.</i> indet. (2 spp.?) ²¹			J†, K	J(78-79)	-	-
† <i>Phorocera assimilis</i> (Fallén) "P. sp." indet.		Y	J		-	
" <i>Sturmia</i> sp." indet.	Y				-	
Tachinid spp. indet. ²²	Y	Y*, M*	Ir*, J*, K*, Y*	J(78-79), U(81)	+	-
Heteroptera:						
Pentatomidae:						
<i>Dinorhynchus dybowskyi</i> Jakovlev			J	J(78-81,85)	-	+
Pentatomid sp. indet. (nymph)			Ir		-	
Coleoptera:						
Carabidae:						
<i>Calosoma maximoviczi</i> (Morawitz)				J(78)		-
<i>C. sycophanta</i> (L.)		A, Y	A*, Ir*, M*		+	
Silphidae:						
<i>Xylodrepa sexcarinata</i> Motschulsky				J(79)		-

Table 1. Continued.

Taxonomic Classification and Genus and Species ²	Origin of Collections and Years of Shipment ¹				Shipped from Quarantine ⁴	
	1963-71	1972-74	1975-77	1978-85	1963-77	1978-85
Dermestidae:						
<i>Anthrenus verbasci</i> (L.)		M			-	
<i>Trogoderma versicolor</i> (Creutzer) ²³		M			- ²³	
Trogositidae:						
<i>Tenebroides maroccanus</i> Reitter		M			-	
Tenebrionidae:						
<i>Akis bacarozzo</i> (Schrank)			M		-	
Nematoda:						
Mermithidae:						
<i>Hexameris</i> spp. (4 spp.) ²⁴		A, G	A, J, U	J(79,82), F(80), In(82)	+	+
Pathogens: viral, fungal		A, G	A, In, Ir, J, P	J(78-79, 84), R(78) Ch(80-83), In(82), K(84) ²⁵	+	+

¹ This is a nomenclatural up-dating of Table 6.1-1 of Doane and McManus 1981, and includes an additional 7 years of shipment data.

² A dagger sign (†) in this column (or in the source column) indicates that that species (or that species from that source) was collected from hosts other than gypsy moths (*Lymantria dispar* (L.) and Oriental subspecies, and *L. obfuscata* (Walker) in India) for trial on gypsy moth in the U.S.; *Dolichogenidea lacteticolor* and *Meteorus versicolor* from France were recovered from the brown-tail moth, *Euproctis chrysothoea* (L.); *Gregopimpla himalayensis* from Japan were recovered from *Orgyia recens approximans* Butler; *Meloboris* sp. and *Tranosema rostrale* from Poland were recovered from the rusty tussock moth, *Orgyia antiqua* (L.); *Brachymeria lasus* from Korea were recovered from the fall webworm, *Hyphantria cunea* (Drury); the *Blepharipa "sericariae"* and the 1976 shipment of *Parasetigena* sp. from Japan, and *Exorista sorbillans* from Korea, were recovered from the silkworm, *Bombyx mori* (L.). *Blepharipa schineri* and *Phorocera assimilis*, and some of *B. sp.* indet. and *Parasetigena sivestris*, from Japan in 1977, were collected as adults from a gypsy moth infestation, and thus actual hosts are unknown.

³ A = Austria; C = Corsica; Ch = People's Republic of China; F = France; G = Germany; In = India; Ir = Iran; J = Japan; K = Korea; M = Morocco; P = Poland; R = Romania; S = Spain; Sa = Sardinia; U = USSR; Y = Yugoslavia.

⁴ A plus sign (+) in this column indicates shipments of the species were made from quarantine (ARS Beneficial Insects Research Laboratory (BIRL), Newark, Delaware). An asterisk (*) in the Origin column indicates material from that source was not included among material shipped from quarantine.

⁵ "*Apanteles* spp." shipped from Spain in 1964-65 and 1968-69 were first shipped as "*A. vitripennis*," and were later found to include primarily *Glyptapanteles porthetriae*, but possibly also included *G. tiparidis* and other species.

- ⁶ "*Apanteles* spp." shipped from Yugoslavia in 1970 included primarily *Glyptapanteles liparidis*, with some *Cotesia melanoscela* and possibly other species including *C. ocnertia* (Ivanova).
- ⁷ "*Apanteles* spp." shipped from India in 1970-71 probably included *Glyptapanteles flavicoxis*, *G. indiensis*, *G. liparidis*, and *Cotesia melanoscela*, and possibly other species.
- ⁸ Gupta (1983) treats *Gregopimpla* as a subgenus of *Iseropis*; these are considered separate genera by R. W. Carlson in Krombein et al. (1979).
- ⁹ In 1970, one shipment of 8 adults of "Ichneumonid sp.," and one shipment of a single adult "Hymenoptera sp.," all of Yugoslavian origin, were shipped from quarantine to the New Jersey Department of Agriculture (NJDA), Trenton. In 1974, a shipment of a single adult "ichneumonid sp." from Morocco was sent to NJDA from quarantine. In 1975, two adult "ichneumonid sp." emerged and died in quarantine from Moroccan material. According to R. J. Dysart and L. R. Erle (BIRL, ARS; personal communication, 1982), the Yugoslavian specimens were probably *Phobocampe* sp., and the Moroccan specimens *Vulgichneumon (= Melanichneumon)* sp. However, no specimens exist to confirm this. There was no culture or release of any of this material.
- ¹⁰ Gupta (1983) treats *Vulgichneumon* as a subgenus of *Melanichneumon*; these are considered separate genera by R. W. Carlson in Krombein et al. (1979).
- ¹¹ Determination of the 1978-81 specimens are by E. E. Grissell, Systematic Entomology Laboratory (SEL), ARS, Washington, D.C.
- ¹² Shipment made in 1979 from quarantine was from a laboratory culture originating from 1976 Austrian collections.
- ¹³ The "*Anastatus* sp." from India in 1966-67 may have included *A. ?kashmirensis* and other species.
- ¹⁴ Correction of misidentification by E. E. Grissell, SEL, ARS. The Indian population was uniparental, the Japanese population biparental. No live material was received from Korea in 1978.
- ¹⁵ The 1972 and 1976 material from India was probably *B. intermedia* but may have included *B. lasus*; the few adults that emerged from the 1976 material were *B. intermedia*.
- ¹⁶ Shipments of "*Telenomus* spp." from Morocco in 1975-76 included 1-2 species of *Telenomus* and a species of *Gryon*; the latter may possibly be a parasite of pentatomid eggs rather than of gypsy moth eggs.
- ¹⁷ Determination by R. J. Gagné, SEL, ARS.
- ¹⁸ Some of the 1977 material was collected as adults; see footnote 2. The unemerged and/or undetermined Japanese specimens from 1976-79 collections were probably *B. schineri*; some adults emerged from the 1979 material and were identified as *B. schineri* by D. D. Wilder, SEL, ARS.
- ¹⁹ This 1973 shipment from Yugoslavia was apparently never identified and may have been *C. separata*.
- ²⁰ Shipments of this species, as "*Drino discreta*," may have included some *P. solennis* (Walker) (see Sabrosky and Reardon, 1976).
- ²¹ The *Parasetigena* sp. from *Bombyx mori* was from Japan in 1976 (not from Korea as given in Table 6.1-1 of Coulson in Doane and McManus (1981). The *P.* sp. from Korea in 1977 was from *Lymantaria dispar*, and is probably a new species, according to C. W. Sabrosky, SEL, ARS, *in litt.*, 1978.
- ²² Many shipments of tachinid puparia were received from which no adults emerged and thus no identifications were made; these may represent species listed above.
- ²³ Table 6.1-1 of Coulson in Doane and McManus (1981) is in error; no live specimens of this species were removed from quarantine.
- ²⁴ Taxonomic study of specimens of the 1974-1977 European and Japanese gypsy moth nematodes were conducted by H. Kaiser (University of Graz, Austria), and W. R. Nickle (ARS, USDA, Beltsville, MD) in 1978. Four new species of *Hexameris* were described in an as yet unpublished manuscript: one from Austria, one from the USSR, and two from Japan.
- ²⁵ The fungus *Beauveria* was received from Romania (1978) and *Entomophthora* was received from Japan (1978-79) and India (1982), and *E. aulicae* (Reichardt) Humber was collected in Japan by Dr. R. S. Soper (ARS, Ithaca, NY) in 1984; nuclear polyhedrosis virus (NPV) of *L. dispar* was received from Japan (1978), the People's Republic of China (1980-83), and South Korea (1984).
- ²⁶ The Korean *C. melanoscela* is believed to be a different biotype of the species already established in the United States, and is dubbed "halo" because of a distinct silk halo surrounding the cocoon of this strain.

al., 1981). Visiting U.S. scientists brought back samples of gypsy moth virus from China in 1980, 1981 and 1982. The 1980 material was sent to Pennsylvania State University (Coulson et al., 1982: Appendix 23), while the 1981–1982 material was sent to the U.S. Forest Service laboratory at Hamden, Connecticut (Lewis et al., 1984). A shipment of *Anastatus* parasites was also received from China in 1981 for study at the ARS laboratory in Newark, Delaware (Coulson, 1982; Fuester, 1982). The 1982 team of U.S. scientists visiting China, consisting of PWS, W. E. Wallner (USFS, Hamden, Connecticut) and R. M. Weseloh (Connecticut Agricultural Experiment Station, New Haven), was able to conduct a rather extensive survey of the gypsy moth and its natural enemies during their travels (Schaefer et al., 1984a, b). PWS returned to China in 1983, with T. M. ODell (USFS, Hamden, Connecticut), for intensive collections in Heilongjiang Province of northeast China. Some live univoltine tachinid parasites were returned to ARS quarantine facilities in Delaware, overwintered, and some F₁ material was released in Delaware in 1985. A paper on the results of the 1983 studies in China is planned. These various shipments of Chinese natural enemies are all noted in Table 1.

Some account of recent work at the ARS Beneficial Insects Research Laboratory at Newark, Delaware, has been given by Fuester (1982, 1985) and Schaefer (1982).

NATURAL ENEMY IMPORTATIONS IN CANADA

To conclude this brief up-date on recent gypsy moth explorations and importations, a few notes on activities in Canada are required. An account of the biological control efforts against the gypsy moth in Canada from 1969 through 1980 was published by Griffiths and Quednau (1984). In view of the spread of the gypsy moth into Canada, Canadian forest entomologists began natural enemy surveys in Canada and have funded some studies on the biological control of the gypsy moth at the European Station of the CIBC since 1974. Apparently the first importation of gypsy moth natural enemies in Canada was the release of the egg parasite, *Ooencyrtus kuvanae*, from the U.S. in Ontario in 1976 (Williamson, 1980; Griffiths and Quednau, 1984). The egg parasite *Anastatus disparis* was imported from Hungary and Romania and released in Quebec in 1979 and in Quebec and Ontario in 1980 (Williamson, 1981a, b; Griffiths and Quednau, 1984). Additional *O. kuvanae* were imported from the U.S. and released in Quebec in 1982, and more *A. disparis* were imported from Europe and released in Ontario and Quebec in 1982 and in New Brunswick, Quebec and Ontario in 1983. A small release of the tachinid parasite *Parasetigena silvestris* from South Tirol, Austria, received from the CIBC, was made at Kaladar, Ontario, in 1984 to supplement the genetic pool of that species. The tachinid *Ceranthia samarensis* was reared from artificial infestations of gypsy moth made by the CIBC in France, in 1984 and 1985. These are being studied by F. W. Quednau, Laurentian Forest Centre, Ste. Foy, Quebec, and V. Nealis, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario. No field releases of this species have been made as yet.

ESTABLISHMENTS

The goal of any natural enemy exploration/importation program is, of course, to establish natural enemies that will be effective in reducing damage caused by the target pest. Establishments resulting from the early gypsy moth natural enemy

importation programs have been reported by a number of authors, including Burgess and Crossman (1929), Dowden (1962), and Clausen (1978). Although several of the newly imported species have been recovered in the field in the year of release, and a few have been recovered in the year following release, there is evidence to date that only two of the natural enemy species newly imported from 1961 to 1985 may have so far become established in the United States. The first is the introduced pupal parasite *Coccygomimus disparis*, which has been sporadically recovered since 1981 and is now believed to be established in Maryland and Pennsylvania (Fuester, 1985) and in New Jersey (R. Chianese, N.J. Department of Agriculture, Trenton, *in litt.*, 1985); a manuscript by PWS and others is in preparation. The second is the larval parasite *Meteorus pulchricornis*, which was recovered from gypsy moth at a single site in Pennsylvania during 1985. No releases of this species had been made in that state since 1977. An earlier single recovery of this polyphagous species had been made in Wisconsin the year following release on a non-gypsy moth lepidopterous host (Shenefelt and Coppel, 1977). No additional recoveries have been made in Wisconsin (H. C. Coppel, University of Wisconsin, Madison, personal communication, 1985).

Hoy (1976) has presented an analysis of the possible reasons for the establishment or non-establishment of some of the parasites imported during the early importation programs, and of some imported early in the more recent program. The scope of this paper does not encompass a record of the release of the natural enemies received, but is only a brief up-dated account of the recent explorations and importations. As noted above, Dr. Dysart is currently completing such a record of releases. No comments can be made here concerning many of the points made by Hoy beyond those made in Doane and McManus, 1981, except that it can be stated that the list of geographical areas noted by Hoy as being inadequately surveyed for new natural enemies of the gypsy moth has been shortened. The apparently strong establishment of *Coccygomimus disparis* as a result of these recent importations is encouraging. Although it is premature to claim establishment of *Meteorus pulchricornis* based on a single recovery, it is also encouraging that this species has managed to survive in nature for eight years following its release in 1977 in Dauphin County, Pennsylvania, the same county in which it was recovered. What, if any, impact these parasites may have on gypsy moth populations, should their own populations build significantly, remains to be seen.

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